Influence of Marble Dust as Partial Replacement of Cement in Concrete

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***Abstract*--The main objective of this research is to investigate the performance of concretes contained marble dust as a cement replacement, mix was prepared with cement and sand blended with marble dust with replacement from 10%, 20%, 25% and 30%.The investigation indicates that replacement of cement by marble waste powder at different ranges, in concrete production, results in higher compressive strength, split tensile strength and flexural strength as of concrete specimens without marble dust.**

Keywords: Marble dust, compressive strength, flexural strength, split tensile strength

I. INTRODUCTION

Concrete is a widely used vital material in the construction world. Producing cement in huge amount in factories directly influences the green house gases emission. Reductions in getting good quality limestone directly affect the production of good quality cement. Higher cement content of High Strength Concrete significantly affects the quality at the hardened state due to shrinkage and greater evaluation of heat of hydration. The cost of construction also gets escalated and also leaving the waste materials to the environment directly can cause environmental problem. Hence the reuse of waste material has been emphasized.

Blended cements based on the partial replacement of Portland cement clinker (PC) by wastes have been the subject of many investigations in recent years. The advancement of concrete technology can reduce the consumption of natural resources and energy sources and lessen the burden of pollutants on environment.The use of the replacement materials offer cost reduction, energy savings, arguably superior products, and fewer hazards in the environment. These materials participate in the hydraulic reactions, contributing significantly to the composition and microstructure of hydrated product.

All these problems can be minimized by partial substitution of industrial waste such as marble dust in cement and also Marble stone industry generates both solid waste and stone slurry. Whereas solid waste results from the rejects at the mine sites or at the processing units, stone slurry is a semi liquid substance consisting of particles originating from the sawing and the polishing processes and water used to cool and lubricate the sawing and polishing machines. Stone slurry generated during processing corresponds to around 40% of the final product from stone industry. This is relevant because the stone industry presents an annual output of 68 million tonnes of processed products.

In building industry, Marble has been commonly used for various purposes like flooring, cladding etc., as a building material since the ancient times. The industry's disposal of the marble dust material, consisting of very fine powder, today constitutes one of the environmental problems around the world. In India, marble dust is settled by sedimentation and then dumped away which results in environmental pollution, in addition to forming dust in summer and threatening both agriculture and public health and also the marble processing is one of the most thriving industry the effects . Therefore the scientific and industrial community must commit towards more sustainable practices.Marble dust is not only the economical material but also improves the properties of the concrete so by varying marble dust contents on the physical and mechanical properties of fresh and hardened concrete have been investigated.

II. EXPERIMENTAL PROGRAMME

A. Materials

Ordinary Portland (43 grade) cement was used. It was tested as Per the Indian Standard Specifications IS: 8112-1989 [7].its properties are shown in Table 1. Marble dust was obtained from local Industries. Fine aggregate was natural sand having a 4.75 mm nominal size. The coarse aggregate used in this investigation was 20 mm nominal size. Both aggregates were tested according to BIS: 383-1970[8] .Their physical properties are given in Tables 2.

Table 1: Properties of Cement.

Physical	Test Results	BIS.8112-1989 Obtained Specifications
Normal Consistency (%)	34	-
Initial Setting Time (Min)	48	>30
Final Setting Time (Min)	240	<600
Fineness % (ResidueRetainedOn 90 Micron Sieve)	2.2	<10
Specific Gravity	3.15	-

Table 2: Properties of Aggregates.

Properties	Coarse aggregate	Fine aggregate
Maximum size (mm)	20	4.75
Specific gravity	2.6	2.29
Total Water Absorption (%)	2.50	4.5
Fineness Modulus	6.1	1.75

B. Mixture proportions

Control mixture (0%) was proportioned to have 28-day compressive strength of 30MPa according to BIS: 10262-2009 [9]. The ratio of concrete mix proportion was 1:1.1:2.78; 1 part cement, 1.1 part fine aggregates, and 2.78 part coarse aggregates. Four additional concrete mixtures (M-2, M-3, M-4 and M-5) were proportioned where cement was replaced with 10%, 20% 25% and 30% marble powder by mass respectively. All mixtures had constant water-to-cement ratio of 0.45. The slump of all mixtures was 80 ± 5 mm. Details of mixtures, and values of slump determined as per BIS: 1199-1959 [10]

C. Specimen'spreparation and casting

150 mm concrete cubes were cast for compressive strength, 150 mm diameter x 300 mm high cylinders for splitting tensile strength and 500x100x100 mm beams for flexural strength. All the specimens were prepared in accordance with BIS: 1199-1959 [10]. Soon after casting, test specimens were covered with plastic sheets, and left in the casting room for 24 h at a temperature of about 26 ± 1^{0}C. They were demolded after 24 h, and were put into a water-curing room until the time of testing.

D. Hardened concrete properties

150mmm cubes were tested for compressive strength, 150x 300 mm cylinders for splitting- tensile strength and 500x100x100 mm beams for flexural strength. Tests were performed at the ages of 7 and 28 days in accordance with the provisions of Indian Standard specifications BIS: 516- 1959[11]

III. RESULTS AND DISCUSSION

A. Compressive Strength

The test results are also presented in Table 3. By increasing the marble dust the compressive strength values of concrete tends to increase at each curing age. This trend can be attributed to the fact that marble dusts possess cementing properties. It is also as much effective in enhancing cohesiveness due to lower fineness modulus of the marble powder. Furthermore, the mean strength of concrete mixes with marble dust was 5-10% higher than the reference concretes. However, there is a slight decrease in compressive strength value concrete mix when 30% marble dust is used as compared with that of 25% marble dust mix.

Figure 1: Determination of compressive strength of cube

Table 3: Compressive strength test results

Percentage of Replacement	Compressive Strength in N/mm^2		
	7Days	28Days	90Days
0 %	30.10	37.58	40.13
10%	30.52	39.23	42.33
20%	30.67	42.15	45.12
25%	32.85	43.6	46.78
30%	25.43	30.53	34.55

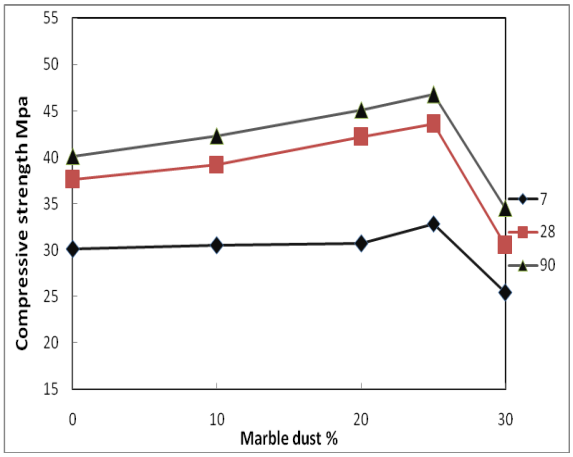

Figure 2: Compressive strength in relation to Marble dust content and curing age.

B. Split Tensile Strength

Split Tensile strength of concrete is tested on cylinders at different percentage of marble dust content in concrete. The strength of concrete has been tested on cylinder at 7 and 28 days. 7 days test has been conducted to check the gain in initial strength of concrete. 28 days test gives the data of final strength of concrete at 28 days curing. Compression

testing machine is used for testing the Split Tensile strength test on concrete along with two wooden boards. At the time of testing the cylinder taken out of water and dried and then tested.

Figure 3: Determination of Split tensile strength of cylinder

Table 4: Split tensile strength test results

Percentage Of Replacement	Split tensile strength N/mm^2	
	7 Days	28 days
0%	2.22	3.40
10%	2.32	3.59
20%	3.02	3.83
25%	3.22	4.07
30%	2.82	3.73

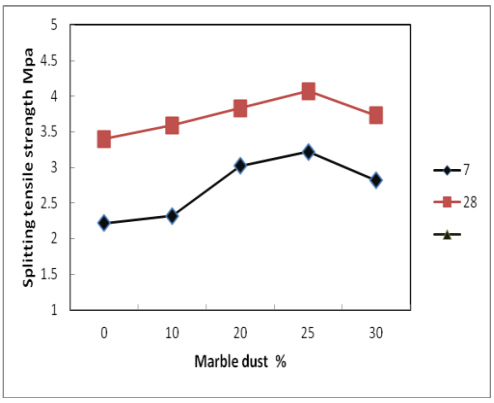

Figure 4:Split tensile strength in relation to Marble dust content and curing age.

C. Flexural Strength

The flexural strength calculations are done as per IS: 516-1959. The results of the flexural strength tests for the marble dust mix concrete are shown in Table 5. The results show that the flexural strength of marble mix concrete increases with the increase of the waste marble ratio in these mixtures. This trend can again be attributed to the fact that marble dust possesses cementing properties.

Figure 5: Determination of Flexural strength of Prism

Table 5: Flexural strength test results

Percentage Of Replacement	Flexure strength N/mm^2	
	7 Days	28 days
0%	4.42	6.3
10%	4.56	6.6
20%	5.3	6.9
25%	5.9	7.27
30%	5.4	6.1

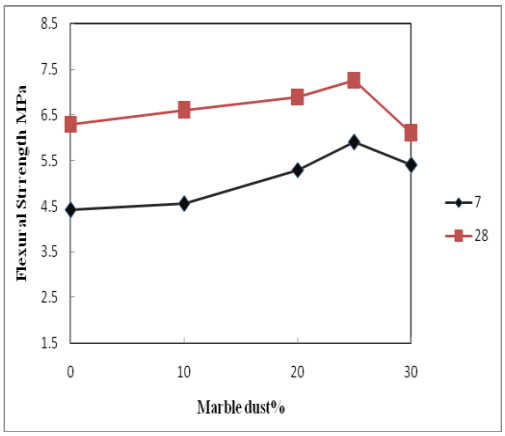

Figure 6: Flexural strength in relation to Marble dust content and curing age.

IV. CONCLUSION

- The Compressive strength, Split Tensile strength and Flexural strength are increased with addition of waste marble dust up to 25% replace by weight of cement.
- Further any addition of waste marble dust the compressive strength, Split Tensile strength and Flexural strength are decreased.
- Therefore , we conclude that the most suitable percentage replacement of marble dust in concrete is 25%.
- Thus we found out the optimum percentage for replacement of marble dust with cement and it is almost 25% cement for cubes, cylinders and prisms.
- Result of this investigation that marble dust could be conveniently used in making good quality concrete and construction materials

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